Agriculture

Effect of Frost on Cereal Grain Crops

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Loss of wheat production due to frost damage is not common in Victoria. However, while the total loss is rarely great, individual growers can suffer heavy losses in some years. The factors exposing crops to loss are discussed along with tips to minimise the potential for frost damage to occur.

Frost tolerance in early growth stages

The degree of tolerance shown by a plant to freezing depends largely on the stage of development at which the stress occurs.

Before the initiation of flowering parts, usually 8-10 weeks after germination, wheat plants are capable of withstanding extreme cold. This is particularly true of winter wheats, which become virtually dormant under the influence of steadily reducing temperature and day length.

Spring wheats, the group which includes most Australian varieties, lack this ability. However, while in this early vegetative stage they may still withstand above-ground temperatures of the order of minus 10°C. In a normal winter, the fairly frequent mild frosts serve to harden the plants, often enabling them to withstand more severe frosting.

Figure 1. Wheat seedlings damaged by frost. This damage is not considered economically important. It may be linked with deep sowing

Figure 2. Wheat at the vegetative stage damaged by severe frost.

Frost susceptibility in later growth stages

Wheat is most susceptible to frost damage in the period from pre-heading to flowering. After the initiation of flowering parts the reaction of the wheat plant to frost changes markedly. This is usually the result of two factors:

* Warmer weather and longer days promote rapid shoot growth and this rapidly growing tissue has low frost hardiness. The young ear tissue is much less tolerant to cold than are the vegetative parts.

* As the stem elongates it is carried away from the protective blanket of the soil and into the zone of minimum temperature.

The main danger to the crop, then, is from spring frosts which strike when the plant is at this susceptible stage.

Radiation frosts

Radiation frosts can be very severe if they come at or near flowering. Such frosts occur when there is a rapid loss of heat by radiation from the ground surface to the air, due to the absence of cloud or moist layers in the upper atmosphere. Air in contact with the ground loses heat by conduction, so that cold air accumulates close to the ground.

In 1980 three consecutive radiation frosts early in November caused considerable losses in an area west and south of Bendigo. In this case the frosts coincided with flowering of later-sown crops. In most years, early-sown crops are more at risk.

A frost in the Wimmera on the morning of 28 October 1998 resulted in loss of yield of 60% in wheat and barley crops, 90% in field peas, 85% in chick peas, 60% in lentils and 40% in canola. Because the temperature fell so low (-2 at Nhill and Longerenong) and remained low for a number of hours, early and late sown crops were all impacted. This became known as a freeze and was estimated to have cost the region up to $200m at the time.

Figure 3. Early sown wheat damaged by frost at pre-heading

Figure 4. Wheat stems damaged by frost. The stem is often bent or twisted between joints because of the death of cells.

Avoiding frost damage

Since the floral tissue is so sensitive to cold, it is unlikely in the foreseeable future that varieties will be developed which are resistant to frost while the plant is flowering. Research has identified genetic variation in tolerance to frost in wheat but new varieties with frost tolerance are not on the horizon.

The best strategy is to avoid frost damage by sowing recommended varieties at suitable times. If sowing both early and late varieties, sow the later maturing one first. In a normal year, this minimises the chance of damage to the early variety by delaying its flowering date beyond the high frost-risk period. Late maturing varieties are not the answer except, perhaps, in southern Victoria. While they escape frosts, they generally run out of moisture at the end of the season and can yield poorly, particularly in northern Victoria.

Ensuring a range of flowering dates for crops minimizes the risk of a major disaster should a frost occur. If crops are timed to flower over a range of dates a severe frost will only damage the portion of the total crop which is susceptible at that time. One paddock or one variety may be severely damaged but the rest of the crop will survive.

Low-lying areas tend to be more frost-prone because cold air accumulates there. Such areas should be sown later where practical. Early sowing is often necessary on soils that crust after rain. Later maturing varieties should be sown in these areas, although another strategy is to sow more frost tolerant crops. Oats appear less susceptible than wheat and barley appears the least susceptible of the three main cereals.

Figure 5. Wheat head damaged by frost.

Figure 6. Thin empty heads of wheat - a result of frost at flowering

Optimum sowing time

Optimum sowing time varies from early-mid May in the Mallee to as late as early July in the high rainfall zones of southern Victoria. Growers needing information for their district should contact their agronomist or local office of DEPI Office.

The pictures show wheat damaged by frost at different stages of growth. In some cases the damage is similar to that caused by the herbicide 2,4-D.

Further reading

"Australian Field Crops", edited by Lazenby and Matheson.

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